

## VNP28N04FI VNB28N04/VNV28N04

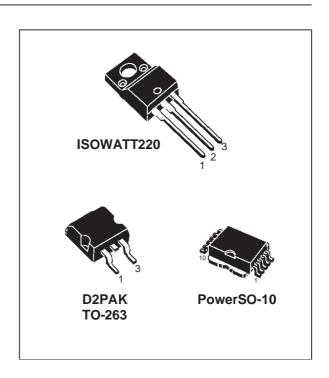
# "OMNIFET": FULLY AUTOPROTECTED POWER MOSFET

TYPE	V <sub>clamp</sub>	R <sub>DS(on)</sub>	l <sub>lim</sub>
VNP28N04FI	42 V	$0.035~\Omega$	28 A
VNB28N04	42 V	$0.035~\Omega$	28 A
VNV28N04	42 V	$0.035 \Omega$	28 A

- LINEAR CURRENT LIMITATION
- THERMAL SHUT DOWN
- SHORT CIRCUIT PROTECTION
- INTEGRATED CLAMP
- LOW CURRENT DRAWN FROM INPUT PIN
- DIAGNOSTIC FEEDBACK THROUGH INPUT PIN
- **■** ESD PROTECTION
- DIRECT ACCESS TO THE GATE OF THE POWER MOSFET (ANALOG DRIVING)
- COMPATIBLE WITH STANDARD POWER MOSFET

#### **DESCRIPTION**

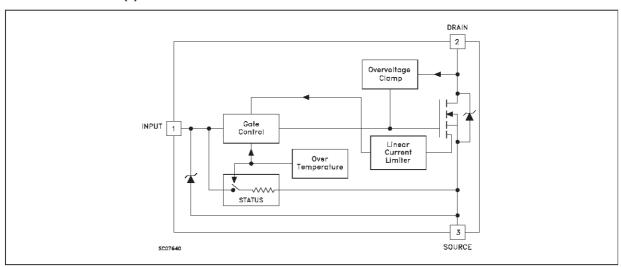
The VNP28N04FI, VNB28N04 and VNV28N04 are monolithic devices made using STMicroelectronics VIPower M0 Technology, intended for replacement of standard power MOSFETS in DC to 50 KHz applications. Built-in thermal shut-down, linear current limitation and overvoltage clamp protect the chip in harsh



enviroments.

Fault feedback can be detected by monitoring the voltage at the input pin.

### **BLOCK DIAGRAM (\*)**



(\*) PowerSO-10 Pin Configuration: INPUT = 6,7,8,9,10; SOURCE = 1,2,4,5; DRAIN = TAB

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### **ABSOLUTE MAXIMUM RATING**

Symbol	Parameter	Va	lue	Unit
		PowerSO-10 D2PAK	ISOWATT220	
V <sub>DS</sub>	Drain-source Voltage (V <sub>in</sub> = 0)	Internally Clamped		V
Vin	Input Voltage	1	8	V
I <sub>D</sub>	Drain Current	Internally Limited		А
I <sub>R</sub>	Reverse DC Output Current	-2	28	Α
Vesd	Electrostatic Discharge (C= 100 pF, R=1.5 KΩ)	20	00	V
P <sub>tot</sub>	Total Dissipation at T <sub>c</sub> = 25 °C	83	34	W
Tj	Operating Junction Temperature	Internally Limited		°C
Tc	Case Operating Temperature	Internally Limited		°C
T <sub>stg</sub>	Storage Temperature	-55 to	o 150	°C

### THERMAL DATA

			ISOWATT220	PowerSO-10	D2PAK	
R <sub>thj-case</sub>	Thermal Resistance Junction-case	Max	3.75	1.5	1.5	°C/W
R <sub>thj-amb</sub>	Thermal Resistance Junction-ambient	Max	62.5	50	62.5	°C/W

# **ELECTRICAL CHARACTERISTICS** (-40 < $T_j$ < 125 $^o\text{C}$ unless otherwise specified) OFF

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
VCLAMP	Drain-source Clamp Voltage	$I_D = 200 \text{ mA}$ $V_{in} = 0$	34	42	51	V
V <sub>CLTH</sub>	Drain-source Clamp Threshold Voltage	$I_D = 2 \text{ mA}$ $V_{in} = 0$	31			٧
VINCL	Input-Source Reverse Clamp Voltage	$I_{in} = -1 \text{ mA}$	-1.1		-0.1	V
I <sub>DSS</sub>	Zero Input Voltage Drain Current (V <sub>in</sub> = 0)	$V_{DS} = 13 \ V  V_{in} = 0$ $V_{DS} = 25 \ V  V_{in} = 0$			100 200	μA μA
I <sub>ISS</sub>	Supply Current from Input Pin	V <sub>DS</sub> = 0 V V <sub>in</sub> = 10 V		250	600	μΑ

### ON (\*)

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
V <sub>IN(th)</sub>	Input Threshold Voltage	$V_{DS} = V_{in}$ $I_D + Ii_n = 1 \text{ mA}$	0.8		3	V
R <sub>DS(on)</sub>	Static Drain-source On Resistance	$V_{in} = 5 \text{ V}$ $I_D = 14 \text{ A}$ -40 < $T_j$ < 25 °C			0.035 0.05	Ω
		$V_{in} = 10 \text{ V}$ $I_D = 14 \text{ A}$ $V_{in} = 5 \text{ V}$ $I_D = 14 \text{ A}$ $T_j = 125  ^{\circ}\text{C}$			0.07 0.1	Ω

### **ELECTRICAL CHARACTERISTICS** (continued)

### **DYNAMIC**

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
g <sub>fs</sub> (*)	Forward Transconductance	V <sub>DS</sub> = 13 V I <sub>D</sub> = 14 A	9	18		S
Coss	Output Capacitance	$V_{DS} = 13 \text{ V}$ f = 1 MHz $V_{in} = 0$		700	1100	pF

### SWITCHING (\*\*)

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
t <sub>d(on)</sub>	Turn-on Delay Time	V <sub>DD</sub> = 15 V I <sub>d</sub> = 14 A		100	300	ns
t <sub>r</sub>	Rise Time	$V_{gen} = 10 \text{ V}$ $R_{gen} = 10 \Omega$		330	800	ns
t <sub>d(off)</sub>	Turn-off Delay Time	(see figure 3)		400	900	ns
t <sub>f</sub>	Fall Time			155	400	ns
t <sub>d(on)</sub>	Turn-on Delay Time	V <sub>DD</sub> = 15 V I <sub>d</sub> = 14 A		450	900	ns
tr	Rise Time	$V_{gen} = 10 \text{ V}$ $R_{gen} = 1000 \Omega$		1.7	4	μs
t <sub>d(off)</sub>	Turn-off Delay Time	(see figure 3)		7.5	25	μs
t <sub>f</sub>	Fall Time			3.4	10	μs
(di/dt) <sub>on</sub>	Turn-on Current Slope	V <sub>DD</sub> = 15 V I <sub>D</sub> = 14 A		35		A/μs
		$V_{in} = 10 \text{ V}$ $R_{gen} = 10 \Omega$				
Qi	Total Input Charge	$V_{DD} = 12 \text{ V}$ $I_{D} = 10 \text{ A}$ $V_{in} = 10 \text{ V}$		60		nC

### SOURCE DRAIN DIODE

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
V <sub>SD</sub> (*)	Forward On Voltage	I <sub>SD</sub> = 14 A V <sub>in</sub> = 0			2	V
t <sub>rr</sub> (**)	Reverse Recovery	$I_{SD} = 14 \text{ A}$		180		ns
Q <sub>rr</sub> (**)	Reverse Recovery Charge	(see test circuit, figure 5)		0.45		μC
I <sub>RRM</sub> (**)	Reverse Recovery Current			7		А

### **PROTECTION**

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit
I <sub>lim</sub>	Drain Current Limit	$V_{in} = 10 \text{ V}$ $V_{DS} = 13 \text{ V}$ $V_{in} = 5 \text{ V}$ $V_{DS} = 13 \text{ V}$	19 19	28 28	41 41	A A
t <sub>dlim</sub> (**)	Step Response Current Limit	V <sub>in</sub> = 10 V V <sub>in</sub> = 5 V		25 70	40 120	μs μs
T <sub>jsh</sub> (**)	Overtemperature Shutdown		150			°C
T <sub>jrs</sub> (**)	Overtemperature Reset		135			°C
I <sub>gf</sub> (**)	Fault Sink Current	$V_{in} = 10 \text{ V}$ $V_{DS} = 13 \text{ V}$ $V_{in} = 5 \text{ V}$ $V_{DS} = 13 \text{ V}$		50 20		mA mA
E <sub>as</sub> (**)	Single Pulse Avalanche Energy	starting $T_j = 25$ °C $V_{DD} = 20$ V $V_{in} = 10$ V $R_{gen} = 1$ K $\Omega$ L = 10 mH	2.5			J

<sup>(\*)</sup> Pulsed: Pulse duration = 300 μs, duty cycle 1.5 % (\*\*) Parameters guaranteed by design/characterization

#### PROTECTION FEATURES

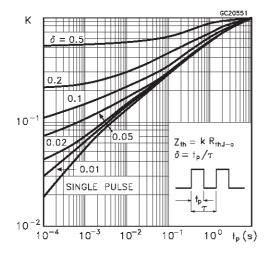
During normal operation, the Input pin is electrically connected to the gate of the internal power MOSFET. The device then behaves like a standard power MOSFET and can be used as a switch from DC to 50 KHz. The only difference from the user's standpoint is that a small DC current ( $l_{iss}$ ) flows into the Input pin in order to supply the internal circuitry.

The device integrates:

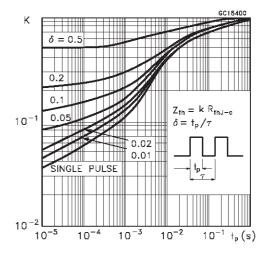
- OVERVOLTAGE CLAMP PROTECTION: internally set at 42V, along with the rugged avalanche characteristics of the Power MOSFET stage give this device unrivalled ruggedness and energy handling capability. This feature is mainly important when driving inductive loads.
- LINEAR CURRENT LIMITER CIRCUIT: limits the drain current ld to llim whatever the Input pin voltage. When the current limiter is active, the device operates in the linear region, so power dissipation may exceed the capability of the heatsink. Both case and junction temperatures increase, and if this phase lasts long enough, junction temperature may reach the overtemperature threshold T<sub>ish</sub>.
- OVERTEMPERATURE AND SHORT CIRCUIT PROTECTION: these are based on sensing the chip temperature and are not dependent on the input voltage. The location of the sensing element on the chip in the power stage area ensures fast, accurate detection of the junction temperature. Overtemperature cutout occurs at minimum 150°C. The device is automatically restarted when the chip temperature falls below 135°C.
- STATUS FEEDBACK: In the case of an overtemperature fault condition, a Status Feedback is provided through the Input pin. The internal protection circuit disconnects the input from the gate and connects it instead to ground via an equivalent resistance of 100  $\Omega$ . The failure can be detected by monitoring the voltage at the Input pin, which will be close to ground potential.

Additional features of this device are ESD protection according to the Human Body model and the ability to be driven from a TTL Logic circuit (with a small increase in  $R_{DS(on)}$ ).

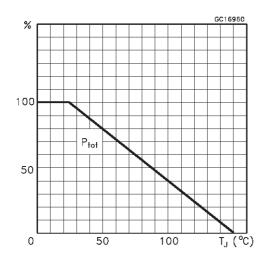
### Thermal Impedance For ISOWATT220



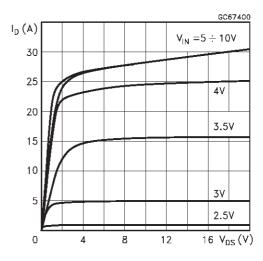
### Thermal Impedance For D2PAK $\,/\,$ PowerSO-10



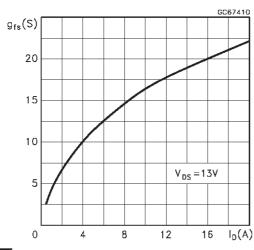
### **Derating Curve**



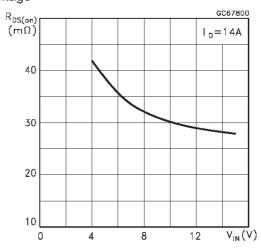
**Output Characteristics** 



### Transconductance

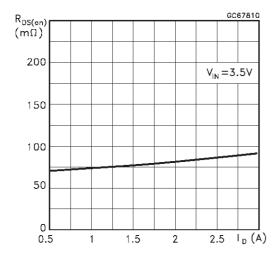


Static Drain-Source On Resistance vs Input Voltage

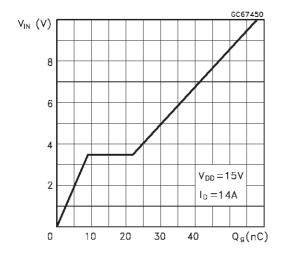


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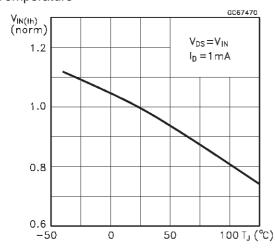
### Static Drain-Source On Resistance



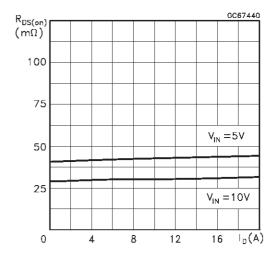
### Input Charge vs Input Voltage



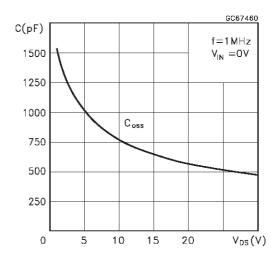
# Normalized Input Threshold Voltage vs Temperature



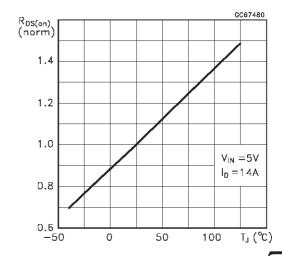
### Static Drain-Source On Resistance



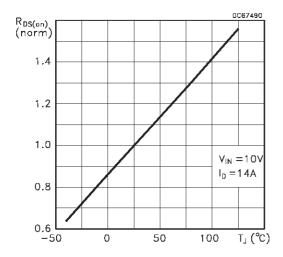
### Capacitance Variations



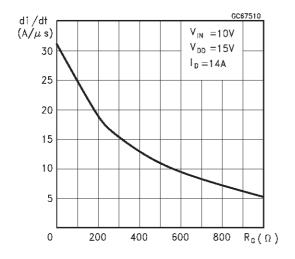
### Normalized On Resistance vs Temperature



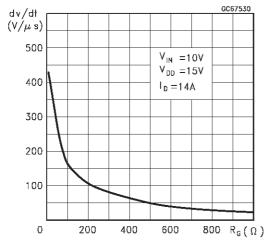
### Normalized On Resistance vs Temperature



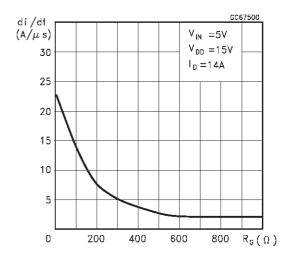
### Turn-on Current Slope



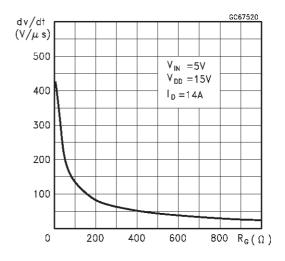
### Turn-off Drain-Source Voltage Slope



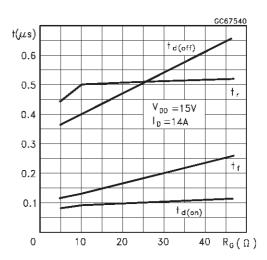
### Turn-on Current Slope



### Turn-off Drain-Source Voltage Slope

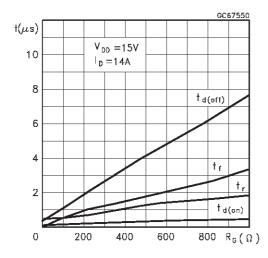


### Switching Time Resistive Load

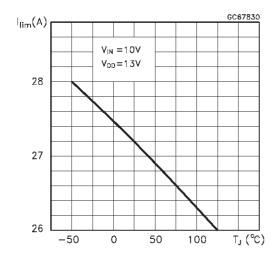


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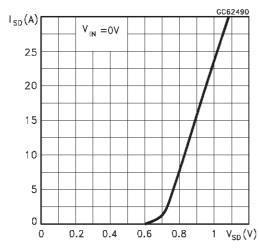
### Switching Time Resistive Load



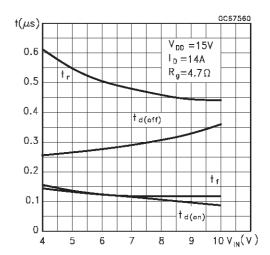
### Current Limit vs Junction Temperature



### Source Drain Diode Forward Characteristics



### Switching Time Resistive Load



### Step Response Current Limit

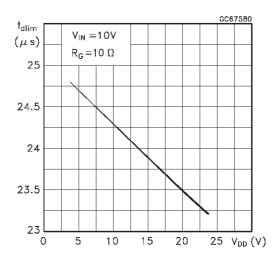
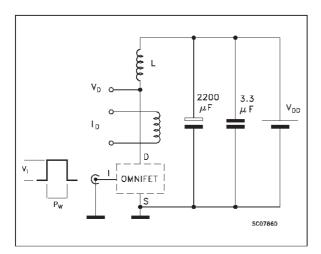
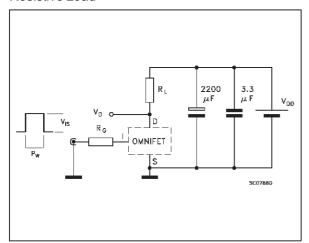


Fig. 1: Unclamped Inductive Load Test Circuits



**Fig. 3:** Switching Times Test Circuits For Resistive Load



**Fig. 5:** Test Circuit For Inductive Load Switching And Diode Recovery Times

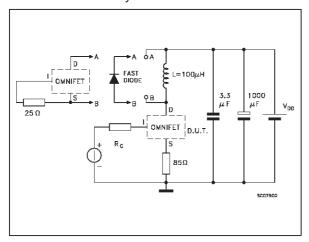


Fig. 2: Unclamped Inductive Waveforms

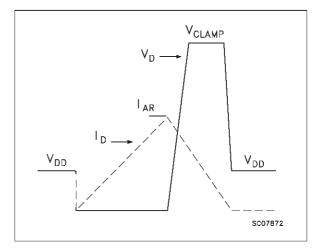


Fig. 4: Input Charge Test Circuit

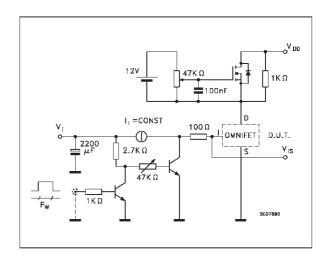
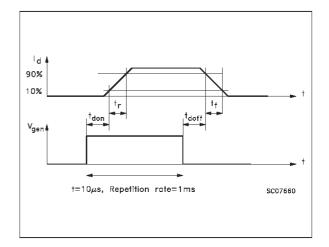


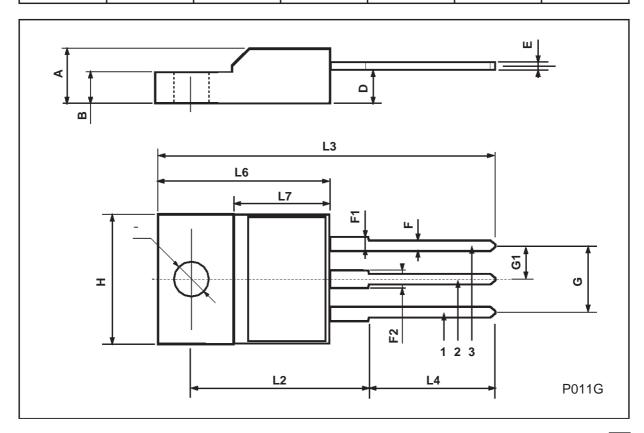
Fig. 6: Waveforms



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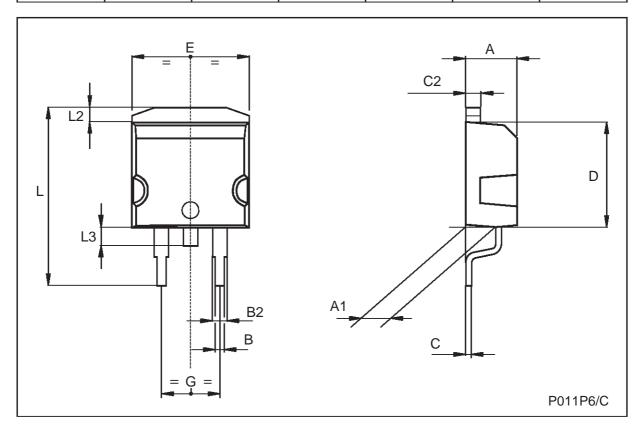
### **ISOWATT220 MECHANICAL DATA**

DIM.		mm			inch	
DIIVI.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
А	4.4		4.6	0.173		0.181
В	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
E	0.4		0.7	0.015		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.7	0.045		0.067
F2	1.15		1.7	0.045		0.067
G	4.95		5.2	0.195		0.204
G1	2.4		2.7	0.094		0.106
Н	10		10.4	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.8		10.6	0.385		0.417
L6	15.9		16.4	0.626		0.645
L7	9		9.3	0.354		0.366
Ø	3		3.2	0.118		0.126



## TO-263 (D2PAK) MECHANICAL DATA

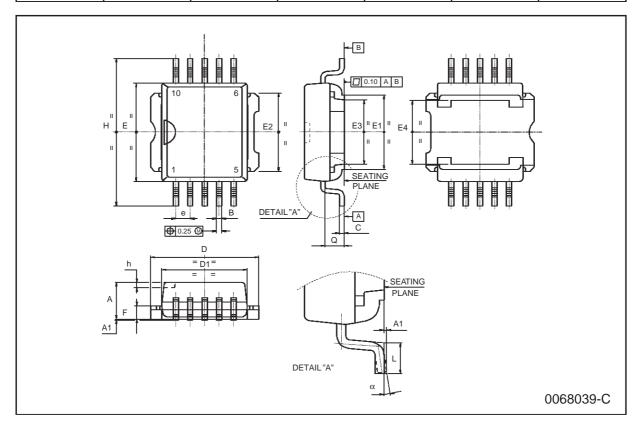
DIM.		mm			inch		
Dim.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
А	4.3		4.6	0.169		0.181	
A1	2.49		2.69	0.098		0.106	
В	0.7		0.93	0.027		0.036	
B2	1.25		1.4	0.049		0.055	
С	0.45		0.6	0.017		0.023	
C2	1.21		1.36	0.047		0.053	
D	8.95		9.35	0.352		0.368	
E	10		10.28	0.393		0.404	
G	4.88		5.28	0.192		0.208	
L	15		15.85	0.590		0.624	
L2	1.27		1.4	0.050		0.055	
L3	1.4		1.75	0.055		0.068	



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### **PowerSO-10 MECHANICAL DATA**

DIM.		mm			inch	
DIIVI.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
Α	3.35		3.65	0.132		0.144
A1	0.00		0.10	0.000		0.004
В	0.40		0.60	0.016		0.024
С	0.35		0.55	0.013		0.022
D	9.40		9.60	0.370		0.378
D1	7.40		7.60	0.291		0.300
Е	9.30		9.50	0.366		0.374
E1	7.20		7.40	0.283		0.291
E2	7.20		7.60	0.283		0.300
E3	6.10		6.35	0.240		0.250
E4	5.90		6.10	0.232		0.240
е		1.27			0.050	
F	1.25		1.35	0.049		0.053
Н	13.80		14.40	0.543		0.567
h		0.50			0.002	
L	1.20		1.80	0.047		0.071
q		1.70			0.067	
α	0°		8°			



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